The stays have to support:
1. Their own weight and attachments 18.00 tons.
2. The weight of the landward and quarters of the platform, equal to one-half of the roadway, less the parts resting on shed 65.00
3. The weight of the 42 guys attached to this portion, and a quarter of a ton strain on each of the inclined guys 12.40
The total weight resting on stays, not tons 95.40
The strain produced by this load is,
By (4) 95.4 x 2.14 = 204.15 tons
The calculated strength of the cables has thus been determined. It must be remembered that all the "tons" above given are United States tons of 2000 lbs. each.
The manufacturers' rule for ascertaining the strength of the best quality of charcoal wire rope heretofore made is as follows:
If \( w \) = the weight of the rope in pounds per fathom, 
\( B \) = its breaking weight in tons, then, making all due allowance for the lay, \( B = 2 w \).
This rope weighs 54 lb. per fathom, and its breaking strength
\( B = 2 \times 54 = 108 \) English tons = 120.96 U.S. tons.
There is good reason, however, to believe, from the superior quality of the material employed in their manufactures, that the strength of the ropes used for the Clifton Bridge is even greater than this. The wire was drawn to a specified tension of 100,000 lb. on the square inch, and the registry of tests shows that, on the whole, they exceeded it. While the ropes were being made at Gateshead, Mr. Keefer witnessed the breaking of one of the wires by direct weights and lever power. The diameter was .154 in., the weight per fathom, .375 lb. It broke with a weight of 1920 lb. Since a bar of wrought iron, 1 yard long, and 1 inch square, weighs 10 lb., we have
10 \( .188 = 53.2 \) wires of this size to the square inch, and the strength of the wire is 53.2 x 1920 = 102,144 lb. per square inch, and the strength of the rope by this test is

133 x 1920 = 255,360 lb., 127.800
and, deducting 5 per cent. for rope making 6.384
the breaking weight, \( B = 121.296 \).

It is therefore within bounds to assume that the breaking strain is at least 121 tons, and, consequently, that the two cables possess an ultimate strength of 121 x 14 = 1694 tons net.
By the same rule the ultimate strength of the stays is estimated by Mr. Keefer as follows:

<table>
<thead>
<tr>
<th>Stays, in. circ.</th>
<th>lb. per fathom</th>
<th>English tons</th>
<th>English tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>12... 44...</td>
<td>20</td>
<td>40</td>
<td>489</td>
</tr>
<tr>
<td>24... 3½...</td>
<td>11</td>
<td>22</td>
<td>528</td>
</tr>
<tr>
<td>12... 3...</td>
<td>8</td>
<td>16</td>
<td>192</td>
</tr>
</tbody>
</table>
48 stays have an average breaking strength of 1260 U.S. tons. By (5) the permanent load exerts a strain upon the cables of 1/5.98 parts, between one-fifth and one-sixth their breaking strength.
By (6) the permanent load on the stays exerts a strain of 1/6.58 parts, between one-sixth and one-seventh their ultimate strength.

Collectively:

<table>
<thead>
<tr>
<th>On Cables</th>
<th>On Stays</th>
</tr>
</thead>
<tbody>
<tr>
<td>tons</td>
<td>tons</td>
</tr>
<tr>
<td>167.50</td>
<td>95.40</td>
</tr>
<tr>
<td>263</td>
<td>507.50</td>
</tr>
</tbody>
</table>

The permanent loads are 167.50 + 95.40 = 263
The resulting strains are 167.50 x 204.15 = 337.21
The breaking strains are 1694 + 1844 = 3538

Hence the entire weight of the bridge, 263 tons, produces a strain on the line of the ropes forming the cables and stays of 507.50 tons, which is as nearly as possible one-sixth their breaking strength of 3038 tons, or 20/3 tons upon each rope of 121 tons' strength. This leaves a safe margin for the effects of the wind and moving loads, and any sudden accumulation of ice and snow.

Being designed for light traffic, the bridge may be considered safe, if the permanent load does not exceed one-fifth, and the permanent and transitory loads, taken together, do not exceed one-fourth the breaking weight. Let \( P \) = weight of the bridge, the permanent load.
\( L \) = greatest load admissible upon the bridge.
\( T \) = the factor of tension on cables and stays produced by \( P + L \).

\( B \) = breaking weight of cables and stays.

Then allowing a strain of 25 per cent. of the breaking strain, the greatest load

\( L = \frac{B}{4T} \) 
and by substitution, for cables,

\( L = \frac{1694}{4 \times 1.81} = 353.8 \) U.S. tons.

and by substitution, for stays,

\( L = \frac{1344}{4 \times 2.74} = 95.40 \) U.S. tons.

The maximum load on the whole bridge is 127.74.

While, therefore, a load of 127.74 U.S. tons equally distributed would not strain the ropes to more than 25 per cent. of their full strength, there can be no question of the sufficiency of the structure to sustain safely the load of 100 tons, for which it was designed. In point of fact, in the course of construction, the cables were put to a test which is equivalent to this load, before any of the stays, which carry half the load, were stretched. Before these relieved the cables of any part of the weight, the latter alone sustained for some weeks during the storms of autumn nearly the whole weight of the bridge. The dead weight they bore at such disadvantage, including their own, was 211 tons. Their deflection at that time being 88.80 ft., the strain produced upon them by this